

What is claimed is:

1. A method, comprising:

in a solution having a specific acidic pH and containing metal cations, adding (i) an amphipathic, heterocyclic, metal-coordinating compound and (ii) a sorbent, such that the addition at the specific acidic pH causes at least some of the metal-coordinating compound to bind with some of the metal cations and at least some of the metal-coordinating compound sorbs to the sorbent, along with any metal cations bound therewith.

2. The method of claim 1 wherein said sorbent includes activated carbon.

3. The method of claim 1 wherein said metal-coordinating compound includes a binding portion containing a plurality of heteroatoms and a hydrophobic portion for sorbing to the sorbent.

4. The method of claim 1 wherein the metal-coordinating compound is selected from the group consisting of a benzotriazole and a benzothiazole.

5. The method of claim 1 wherein said specific pH is in a range from approximately pH 2 to pH 6 and said metal-coordinating compound is Benzotriazole, Benzothiazole or Methylbenzotriazole.

6. The method of claim 5 wherein said sorbent is an H type activated carbon.

7. The method of claim 1 wherein said specific pH is less than approximately 2.

8. The method of claim 7 wherein said metal-coordinating compound is selected as at least one of Carboxybenzotriazole, any fatty acid conjugated Benzotriazole derivative, butylbenzotriazole, other aliphatic conjugated Benzotriazole and Benzothiazole.

9. The method of claim 7 wherein said sorbent is an acidic activated carbon.

10. The method of claim 7 wherein said sorbent is an L type activated carbon.

11. The method of claim 9 wherein said metal-coordinating compound is at least one of Benzotriazole and Benzothiazole.

12. The method of claim 11 wherein said sorbent is an acidic activated carbon.

13. The method of claim 11 wherein said sorbent is an L type activated carbon.

14. The method of claim 1 including enclosing the sorbent and the metal-coordinating compound in a liquid permeable enclosure through which said acidic solution passes.

15. The method of claim 14 including equilibrating the sorbent and the metal-coordinating compound prior to said enclosing.

16. The method of claim 1 including removing from the solution the metal-coordinating compound sorbed to the sorbent and the metal cations bound with the sorbed metal-coordinating compound.

17. The method of claim 1 wherein the metal cations bind the metal-coordinating compound by each metal ion coordinating with a plurality of heteroatoms of the metal-coordinating compound.

18. The method of claim 1 wherein adding includes forming a combination of the metal-coordinating compound sorbed to the sorbent and, thereafter, introducing the combination into said solution.

19. The method of claim 1 wherein adding includes separately introducing each of the metal-coordinating compound and the sorbent to said solution.

20. The method of claim 19 wherein said metal-coordinating compound is introduced before said sorbent is introduced.

21. The method of claim 1 wherein said metal-coordinating compound includes a ring selected from the group consisting of a triazole ring and a thiazole ring and the metal cations bind with said ring.

22. The method of claim 1 wherein said solution is aqueous and adding includes selecting a compound from the group consisting of a benzotriazole and a benzothiazole as said metal-coordinating compound.

23. The method of claim 22 wherein selecting is based, at least in part, on said specific pH.

24. The method of claim 1 wherein the metal cations include at least one of an arsenic ion, a cadmium ion, a cobalt ion, a copper ion, a gold ion, a iron ion, a lead ion, a mercury ion, a nickel ion, a selenium ion, a silver ion, and a zinc ion and wherein the method includes selecting as the sorbent an activated carbon.

25. The method of claim 1 wherein (1) said metal cations which are bound with said metal-coordinating compound, and (2) said metal-coordinating compound sorbed to said sorbent form a complexation, said method further comprising:

removing the metal cations from the complexation to recover a base metal of the metal cations.

26. The method of claim 1 including providing said metal-coordinating compound and said sorbent in a dissolvable tablet form.

27. A water associated with an environmentally contaminated site that has been decontaminated by removing metal cations therefrom by the method of claim 1.

28 29. A method for removing metal cations from a solution having a specific acidic pH, said method comprising:

introducing an amphipathic, heterocyclic metal-coordinating compound into the solution at the specific acidic pH, such that at least some of the metal cations bind with the binding compound; and

exposing the solution to a sorbent at said specific acidic pH, so that at least some of the metal-coordinating compound sorbs to the sorbent along with any metal cations bound therewith.

30 30. The method of claim 29 wherein exposing includes (i) enclosing the sorbent in a flow-through enclosure and (ii) causing the solution, including the metal-coordinating compound, to flow through the sorbent in said enclosure for sorbing the metal-coordinating compound and metal cations bound therewith.

31 31. A method for removing metal cations from a solution having a specific acidic pH, said method comprising:

enclosing an amphipathic, heterocyclic metal-coordinating compound and a sorbent in a flow-through enclosure; and

causing said solution to flow through the enclosure such that at least some of the metal cations bind with the binding compound at the specific acidic pH and at least some of the metal-coordinating compound sorbs to the sorbent at said specific acidic pH, in said enclosure, along with any metal cations bound therewith.

32 32. The method of claim 31 including sorbing the metal-coordinating compound to the sorbent before said enclosing.

33 33. The method of claim 31 including equilibrating the metal-coordinating compound with the sorbent before said enclosing.

34 34. A method, comprising:

in a solution having a specific acidic pH and containing metal cations, adding (i) an amphipathic, heterocyclic, metal-coordinating compound and (ii) a sorbent, such that at least some of the metal-coordinating compound and at

least some of the sorbent cooperate at the specific acidic pH to sequester at least some of the metal cations from the solution.

34.35. In a solution, having a specific acidic pH, that is contaminated with metal cations, a method comprising:

binding at least some of the metal cations to an amphipathic, heterocyclic metal-coordinating compound, at said specific acidic pH, for subsequent use.

35.36. The method of claim 35 including sorbing at least some of the metal-coordinating compound and metal cations bound thereto using an activated carbon at the specific acidic pH.

36.37. For use in a system in which metal cations are removed from a solution having a specific acidic pH, an arrangement comprising:

means for adding (i) an amphipathic, heterocyclic metal-coordinating compound and (ii) a sorbent to the solution, such that at least some of the metal cations bind with the metal-coordinating compound at the specific acidic pH and so that at least some of the metal-coordinating compound sorbs to the sorbent, at the specific acidic pH, along with any metal cations bound therewith.

37.38. The arrangement of claim 37 wherein said sorbent includes activated carbon.

38.39. The arrangement of claim 37 wherein said metal-coordinating compound includes a binding portion containing a plurality of heteroatoms and a hydrophobic portion for sorbing to the sorbent.

39.40. The arrangement of claim 37 wherein the metal-coordinating compound is selected from the group consisting of a benzotriazole and a benzothiazole.

40.41. The arrangement of claim 37 wherein said solution is in a range from approximately pH 2 to pH 5 and said metal-coordinating compound is Benzotriazole, Benzothiazole or Methylbenzotriazole.

41.42. The arrangement of claim 41 wherein said sorbent is an H type activated carbon.

42.43. The arrangement of claim 37 wherein said solution includes the specific acidic pH of less than approximately 2.

43.44. The arrangement of claim 43 wherein said sorbent is an acidic activated carbon.

44.45. The arrangement of claim 43 wherein said sorbent is an L type activated carbon.

45.46. The arrangement of claim 37 wherein said metal-coordinating compound selected as at least one of Carboxybenzotriazole, any fatty acid conjugated Benzotriazole derivative, butylbenzotriazole, other aliphatic conjugated Benzotriazole and benzothiazole.

46.47. The arrangement of claim 46 wherein said sorbent is an acidic activated carbon.

47.48. The arrangement of claim 46 wherein said sorbent is an L type activated carbon.

48.49. The arrangement of claim 37 wherein the metal-coordinating compound is an organic ligand.

49.50. The arrangement of claim 37 including a liquid permeable enclosure for housing the sorbent and the metal-coordinating compound therein such that said solution passes therethrough to reach the metal-coordinating compound and the sorbent.

50.51. The arrangement of claim 37 wherein said liquid permeable enclosure is configured for removal from the solution having the metal-coordinating compound sorbed to the sorbent and the metal cations bound with the sorbed metal-coordinating compound.

51.52. The arrangement of claim 37 wherein the metal cations bind with the metal-coordinating compound by each metal ion coordinating with a plurality of heteroatoms of the metal-coordinating compound.

Rule 1.26

53. The arrangement of claim 37 wherein said adding means is configured for receiving a combination of the metal-coordinating compound sorbed to the sorbent and for introducing the combination into said solution.
- 53a. The arrangement of claim 53 wherein the metal-coordinating compound is equilibrated with the sorbent.
- 53b. The arrangement of claim 37 wherein said adding means includes means for exposing the sorbent to said solution after the metal-coordinating compound is introduced to the solution.
- 53c. The arrangement of claim 55 wherein the exposing means includes housing means for receiving said sorbent therein and said housing means is configured for receiving a flow of said solution therethrough, including a combination of the metal-coordinating compound bound with the metal cations, such that the combination sorbs to the sorbent in said housing means.
- 53d. The arrangement of claim 37 wherein said metal-coordinating compound includes a ring selected from the group consisting of a triazole ring and a thiazole ring and the metal cations bind with said ring.
- 53e. The arrangement of claim 37 wherein said solution is aqueous and wherein the metal-coordinating compound is selected from the group consisting of a benzotriazole and a benzothiazole.
- 53f. The arrangement of claim 37 wherein the metal cations include at least one of an arsenic ion, a cadmium ion, a cobalt ion, a copper ion, a gold ion, an iron ion, a lead ion, a mercury ion, a nickel ion, a selenium ion, a silver ion, and a zinc ion and wherein said sorbent is an activated carbon.
- 53g. The arrangement of claim 37 wherein (1) said metal cations which are bound with said metal-coordinating compound, and (2) said metal-coordinating compound sorbed to said sorbent form a complexation, said arrangement further comprising:
means for removing the metal cations from the complexation to recover a base metal of the metal cations.
60. The arrangement of claim 37 formed as a dissolvable tablet.
61. For use in a system for removing metal cations from a solution having a specific acidic pH, an arrangement comprising:
a filter enclosure defining an interior for supporting a flow of said solution therethrough; and
an amphipathic, heterocyclic metal-coordinating compound and a sorbent received within said interior of the filter enclosure for exposure to said flow of the solution such that the metal-coordinating compound and the sorbent cooperate at the specific acidic pH to sequester at least some of the metal cations from solution.
62. The arrangement of claim 61 wherein the metal-coordinating compound is sorbed to said sorbent within said interior of the filter enclosure prior to said flow of said solution.
63. The arrangement of claim 62 wherein the metal-coordinating compound is equilibrated with the sorbent prior to the flow of said solution.
64. The arrangement of claim 62 wherein the metal-coordinating compound and the sorbent are introduced into said interior as separate components such that the metal-coordinating compound sorbs to the sorbent during the flow of said solution.
65. For use in a system in which metal cations are removed from a solution having a specific acidic pH, a product comprising:
a container arrangement containing (i) an amphipathic, heterocyclic metal-coordinating compound and (ii) a sorbent, which container arrangement is adapted for exposing the metal coordinating compound and the sorbent to said solution, such that at least some of the metal cations bind with the metal-coordinating compound at the specific acidic pH and so that at least some of the metal-coordinating compound sorbs to the sorbent at the specific acidic pH, along with any metal cations bound therewith.

Rule 1.26

- ⁶⁶67. The product of claim 66 wherein said metal-coordinating compound and said sorbent are mixed within said container arrangement.
- ⁶⁷68. The product of claim 66 wherein said metal-coordinating compound is sorbed to said sorbent prior to contacting said solution.
- ⁶⁸69. The product of claim 68 wherein said metal coordinating compound and said sorbent are equilibrated prior to contacting said solution.
- ⁶⁹70. The product of claim 66 wherein said metal-coordinating compound and said sorbent are stratified within said container arrangement.
- ⁷⁰71. The product of claim 66 wherein said container arrangement forms at least two separate chambers and each of the metal-coordinating compound and said sorbent is received within one of the chambers.